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GANDHI, DIPAKKUMAR B	
ART UNIT	**PAPER NUMBER**
2138	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/29/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)
	09/822,950	THURSTON, ANDREW J.
	Examiner	Art Unit
	Dipakkumar Gandhi	2138

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 07 November 2006.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-55 is/are pending in the application.

4a) Of the above claim(s) 30 is/are withdrawn from consideration.

5)☒ Claim(s) 38-47 is/are allowed.

6)☒ Claim(s) 1-8,10-29,31-37 and 48-55 is/are rejected.

7)☒ Claim(s) 9 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 30 July 2001 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Response to Appeal Brief

1. Applicant's appeal brief filed on 11/07/2006 has been entered.

2. Applicant's arguments have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter, which the applicant regards as his invention.

4. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps are: "generating a plurality of minimum-degree polynomials based on no more than six equations <u>having</u> no more than two branch decisions" is incorrect. It should be -- generating a plurality of minimum-degree polynomials based on no more than six equations <u>using</u> no more than two branch decisions--.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

7. Claim 1-6, 10, 11, 12, 13, 14, 15, 17, 18, 24, 25, 26, 31, 32, 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Oh et al. (US 5,583,499) in view of Kraft (US 5,343,481), Baggen (US 5,539,755) and Wicker (Error Control Systems for Digital Communication and Storage, 1995, Prentice-Hall, Inc., Page 204).

As per claim 1, Oh et al. teach a method of decoding an error-correction code in a data signal, comprising the steps of: receiving the data signal at a decoding unit; computing a plurality of syndromes associated with the data signal using the decoding unit; and locating errors within the data signal using the error polynomial (col. 1, lines 8-13, col. 1, lines 52 to col. 2, line 1, Oh et al.).

However Oh et al. do not explicitly teach the specific use of extracting an error polynomial from the data signal, wherein the extracting comprises based on no more than six equations having no more than two branch decisions.

Kraft in an analogous art teaches that for a three-error correcting BCH code, there are six components of the syndrome vector S1, S2, ...,S6. Each of these is a Galois Field quantity (col. 1, lines 60-63, Kraft). The examiner would like to point out that these are six syndrome equations.

Wicker teaches t-error-correcting BCH code. Wicker also teaches that $\{X_l\}$ are error locators, for their values indicate the positions of the errors in the received word. We obtain a sequence of 2t algebraic syndrome equations in the v unknown error locations, $S_1, S_2, S_3, S_4, \ldots S_{2t}$ (page 204, Wicker). The examiner would like to point out that for 3-error-correcting BCH code, there are six algebraic syndrome equations.

Kraft also teaches the binary tree of FIG. 2... the calculation means 4 in FIG. 1 (fig. 1, 2, col. 6, lines 2-34, Kraft). Kraft also teaches that the control bits...FIG. 2 occurs (fig. 2, col. 6, lines 33-57, Kraft).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Oh et al.'s patent with the teachings of Kraft by including an additional step of extracting an error polynomial from the data signal, wherein the extracting comprises based on no more than six equations having no more than two branch decisions.

This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that it would provide the opportunity

to reduce the number of circuit components and increase the decoding speed to determine the errors in the received data signal.

Oh et al. also do not explicitly teach the specific use of generating a plurality of minimum-degree polynomials.

However Baggen in an analogous art teaches that the error detecting and correcting properties are determined by the factors of the generator polynomial, i.e., in our case

$g(x)=m_0(x)m_1(x)m_3(x)....$,

where each factor $m_i(x)$ is itself a polynomial. The factors themselves may be minimal (col. 4, lines 60-67, Baggen).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Oh et al.'s patent with the teachings of Baggen by including an additional step of generating a plurality of minimum-degree polynomials.

This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that generating a plurality of minimum-degree polynomial would provide the opportunity to decode data and correct errors.

- As per claim 2, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method, wherein said extracting step extracts the error polynomial in no more than 12 clock cycles (col. 2, lines 19-25, Oh et al.).

- As per claim 3, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method, wherein said extracting step includes the step of controlling a plurality of Galois field multiply accumulators using a state machine (figure 1A, 1B, 1C, 3, col. 3, lines 6-12, lines 15-17, lines 22-25, col. 5, lines 58-63, col. 6, lines 3-5, Oh et al.).

- As per claim 4, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method, wherein each of the plurality of Galois field multiply accumulators represents a different power of the error polynomial (col. 4, lines 44-48, Oh et al.).

- As per claim 5, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Kraft teaches the method wherein said computing, extracting, and locating steps use a Bose-chaudhuri-Hocquenghem (BCH) code (col. 1, lines 9-11, Kraft).

- As per claim 6, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method wherein the computing steps computes 2t syndromes, where t is a number of correctable errors which the error-correcting code can correct (col. 3, lines 28-32, Oh et al.).

- As per claim 10, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method of claim 1 wherein said extracting step includes the step of calculating correction terms using four Galois field multiply accumulators (col. 4, lines 3-6, Oh et al.).

- As per claim 11, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method wherein said locating step locates the errors by determining roots of the error polynomial, which correspond to error locations (col. 1, lines 64-66, Oh et al.).

- As per claim 12, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Wicker teaches the method wherein the locating step uses Chien's algorithm to search for the error location numbers (page 209, Wicker).

- As per claim 13, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Kraft teaches a method of determining an error polynomial for decoding a Bose-Chaudhuri-Hocquenghem (BCH) code (col. 1, lines 28-33, Kraft).

Oh et al. teach computing a plurality of syndromes associated with a data signal having a BCH code embedded therein; feeding the syndromes to a plurality of Galois field multiply accumulators; using the Galois field multiply accumulators and, said calculating and generating steps extracting the error polynomial in no more than 12 clock cycles (col. 1, line 60 to col. 2, line 34, Oh et al.).

Baggen teaches calculating a plurality of minimum-degree polynomials associated with the BCH code and generating an error polynomial based on the minimum-degree polynomials (col. 4, lines 60-67, Baggen).

Wicker teaches t-error-correcting BCH code. Wicker also teaches that $\{X_l\}$ are error locators, for their values indicate the positions of the errors in the received word. We obtain a sequence of 2t algebraic syndrome equations in the v unknown error locations, $S_1, S_2, S_3, S_4, \ldots S_{2t}$ (page 204, Wicker).

- As per claim 14, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Kraft teaches the method wherein said calculating step includes the step of calculating a plurality of coefficients of at least one of the minimum-degree polynomials (col. 5, lines 61-65, Kraft).

- As per claim 15, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method wherein the calculating step includes the step of computing a first correction term using at least one of the Galois field multiply accumulators (col. 2, lines 11-18, Oh et al.).

Kraft teaches that the first correction term being equal to a first one of the syndromes (fig. 2, col. 6, lines 7-11, lines 35-57, Kraft).

- As per claim 17, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Kraft teaches the method wherein the step of computing the first correction term includes the step of operating the at least one Galois field multiply accumulator in a pass-through mode (abstract, Kraft).

- As per claim 18, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Kraft teaches the method wherein: the BCH code is a triple-error correcting code; and the calculating step calculates at least three minimum-degree polynomials (col. 2, lines 43-45, col. 6, lines 35-57, Kraft).

- As per claim 24, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the method wherein there are exactly four of the Galois field multiply accumulators (col. 4, lines 3-6, Oh et al.) and the calculating step includes the step of controlling inputs to the Galois field multiply accumulators using a state machine (figure 1A, 1B, 1C, 3, col. 3, lines 6-12, lines 15-17, lines 22-25, col. 5, lines 58-63, col. 6, lines 3-5, Oh et al.).

- As per claim 25, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach a circuit for generating an error polynomial of a Bose-chaudhuri-Hocquenghem (BCH) code (fig. 3, col. 1, lines 36-37, col. 3, lines 15-17, Oh et al.), comprising: a plurality of syndrome inputs; a plurality of Galois field multiply accumulators; and means for using said Galois field multiply accumulators (col. 1, line 60 to col. 2, line 34, Oh et al.).

Kraft teaches to generate an error polynomial based on values provided at said syndrome inputs, by executing no more than six equations with two branch decisions as follows:

Kraft teaches that for a three-error correcting BCH code, there are six components of the syndrome vector S1, S2, ...,S6. Each of these is a Galois Field quantity (col. 1, lines 60-63, Kraft). The examiner would like to point out that these are six syndrome equations.

Kraft also teaches the binary tree of FIG. 2... the calculation means 4 in FIG. 1 (fig. 1, 2, col. 6, lines 2-34, Kraft). Kraft also teaches that the control bits...FIG. 2 occurs (fig. 2, col. 6, lines 33-57, Kraft).

Wicker teaches t-error-correcting BCH code. Wicker also teaches that $\{X_l\}$ are error locators, for their values indicate the positions of the errors in the received word. We obtain a sequence of 2t algebraic syndrome equations in the v unknown error locations, $S_1, S_2, S_3, S_4, \ldots S_{2t}$ (page 204, Wicker). The examiner would like to point out that for 3-error-correcting BCH code, there are six algebraic syndrome equations.

Baggen teaches generating a plurality of minimum-degree polynomials (col. 4, lines 60-67, Baggen).

- As per claim 26, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the circuit wherein said using means includes a state machine, which asserts control ports on the Galois field multiply accumulators to execute the equations (figure 1A, 1B, 1C, 3, col. 3, lines 6-12, lines 15-17, lines 22-25, col. 5, lines 58-63, col. 6, lines 3-5, Oh et al.).

- As per claim 31, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the circuit wherein said using means uses the Galois field multiply accumulators (fig. 3, col. 5, lines 58-63, Oh et al.).

Kraft teaches calculating a plurality of coefficients of at least one of the minimum-degree polynomials (col. 5, lines 61-65, Kraft).

- As per claim 32, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Oh et al. teach the circuit for calculating the error locator polynomial and using means uses the Galois field multiply accumulators (fig. 3, col. 5, lines 58-63, Oh et al.).

Kraft teaches that the BCH code is a triple-error correcting code; and calculating at least three minimum-degree polynomials (col. 2, lines 43-51, col. 6, lines 35-59, Kraft).

- As per claim 55, Oh et al., Kraft, Baggen and Wicker teach the additional limitations.

Kraft teaches using a non-iterative algorithm to generate the error polynomial from the data signal based on no more than six equations having no more than two branch decisions (fig. 1, 2, col. 1, lines 60-62, col. 6, lines 1-56, Kraft).

Wicker teaches t-error-correcting BCH code. Wicker also teaches that $\{X_l\}$ are error locators, for their values indicate the positions of the errors in the received word. We obtain a sequence of 2t algebraic syndrome equations in the v unknown error locations, $S_1, S_2, S_3, S_4, \ldots S_{2t}$ (page 204, Wicker). The examiner would like to point out that for 3-error-correcting BCH code, there are six algebraic syndrome equations.

8. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Oh et al. (US 5,583,499), Kraft (US 5,343,481), Baggen (US 5,539,755) and Wicker (Error Control Systems for Digital Communication and Storage, 1995, Prentice-Hall, Inc., Page 204) as applied to claim 1 above, and further in view of Erhart et al. (US 5,051,999).

As per claim 7, Oh et al., Kraft, Baggen and Wicker substantially teach the claimed invention described in claim 1 (as rejected above).

However Oh et al., Kraft, Baggen and Wicker do not explicitly teach the specific use of the method wherein the computing step uses a linear feedback register to compute the syndromes.

Erhart et al. in an analogous art teach that each shift of the linear feedback register calculates a subsequent syndrome (col. 3, lines 40-41, Erhart et al.).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Oh et al.'s patent with the teachings of Erhart et al. by including an additional step of using the method wherein the computing step uses a linear feedback register to compute the syndromes. This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that using the method wherein the computing step uses a linear feedback register to compute the syndromes would provide the opportunity to use a programmable linear feedback register programmed with a feedback value corresponding to the generator polynomial and the programmable linear feedback register can be further programmed to receive the n bits of data and calculate syndromes.

9. Claims 8, 16, 19, 20, 21, 22, 23, 27, 28, 29, 33, 34, 35, 36, 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Oh et al. (US 5,583,499), Kraft (US 5,343,481), Baggen (US 5,539,755) and Wicker (Error Control Systems for Digital Communication and Storage, 1995, Prentice-Hall, Inc., Page 204) as applied to claim 1, 13, 25 above, and further in view of Stenerson (US 4,597,083).

As per claim 8, Oh et al., Kraft, Baggen and Wicker substantially teach the claimed invention described in claim 1 (as rejected above).

However Oh et al., Kraft, Baggen and Wicker do not explicitly teach the specific use of the method wherein the computing step includes the steps of: dividing a received code word in the data signal by a minimal Galois polynomial; and evaluating a remainder from said dividing step.

Stenerson in an analogous art teaches that codeword is divisible by a code generator polynomial in the form of a product of a plurality of different factors in the form (x+a.sup.i). Four syndrome signals are derived, each corresponding to a respective first order syndrome equal to the remainder upon dividing a received data block word by a respective factor (abstract, Stenerson).

Stenerson also teaches that the received codeword may be passed through a re-encoder (also known as a syndrome generator), which produces as its output the remainder of the polynomial division s(x)=Remainder [R(x)/g(x)], (col. 4, lines 47-59, Stenerson).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Oh et al.'s patent with the teachings of Stenerson by including an additional step of using the method wherein the computing step includes the steps of: dividing a received code word in the data signal by a minimal Galois polynomial; and evaluating a remainder from said dividing step.

This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that using the method wherein the computing step includes the steps of: dividing a received code word in the data signal by a minimal Galois polynomial; and evaluating a remainder from said dividing step would provide the opportunity to determine error syndromes that can be used with further calculation to determine location of the errors and error values in the code word received.

- As per claim 16, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Stenerson teach the method wherein said calculating step includes the step of computing a second correction term using at least one of the Galois field multiply accumulators, the second correction term being equal to the sum of a product of the first syndrome with a second one of the syndromes, and a third one of the syndromes (col. 7, line 60-64, col. 18, lines 28-33, Stenerson).

- As per claim 19, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Oh et al. teach the Galois field multiply accumulators (col. 4, lines 3-6, Oh et al.).
Kraft teaches computing a first correction term, the first correction term being equal to a first one of the syndromes and computing the third correction term being based in part on coefficients of at least one of the minimum-degree polynomials (fig. 2, col. 6, lines 35-59, Kraft).
Stenerson teaches computing a second correction term using at least one of the Galois field multiply accumulators, the second correction term being equal to the sum of a product of the first syndrome with a second one of the syndromes, and a third one of the syndromes (col. 7, line 62-63, col. 18, lines 28-33, Stenerson).

- As per claim 20, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Kraft teaches the method wherein said calculating step includes the step of determining whether the second correction term is equal to zero (fig. 2, col. 6, lines 2-59, Kraft).

- As per claim 21, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Kraft teaches the method wherein the calculating step equates a first one of the minimum-degree polynomials to a second one of the minimum-degree polynomials in response to a determination that the second correction term is equal to zero (fig. 2, col. 6, lines 2-59, Kraft).

- As per claim 22, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Kraft teaches the method wherein the calculating step includes the step of determining whether the third correction term is equal to zero (fig. 2, col. 6, lines 2-59, Kraft).

- As per claim 23, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations.

Kraft teaches the method wherein the calculating step equates a first one of the minimum-degree polynomials to a second one of the minimum-degree polynomials in response to a determination that the third correction term is equal to zero (fig. 2, col. 6, lines 2-59, Kraft).

- As per claim 27, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations.

Stenerson teaches the circuit wherein the using means computes a first correction term using at least one of the Galois field multiply accumulators, by assigning a value of a first one of the syndromes to the first correction term (col. 9, lines 44-46, col. 18, lines 28-33, Stenerson).

- As per claim 28, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations.

Stenerson teaches the circuit wherein the using means further computes a second correction term using at least one of the Galois field multiply accumulators, the second correction term being equal to the sum of a product of the first syndrome with a second one of the syndromes, and a third one of the syndromes (col. 7, line 62-63, col. 18, lines 28-33, Stenerson).

- As per claim 29, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations.

Stenerson teaches the circuit wherein said using means computes the first correction term by operating at least one Galois field multiply accumulator in a pass-through mode (col. 18, lines 28-33, col. 22, lines 30-34, Stenerson).

- As per claim 33, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations.

Oh et al. teach teaches the circuit wherein the using means uses the Galois field multiply accumulators (col. 4, lines 3-6, Oh et al.).

Kraft teaches computing a first correction term, by assigning a value of a first one of the syndromes to the first correction term and computing a third correction term, the third correction term being based in part on coefficients of at least one of the minimum-degree polynomials (fig. 2, col. 6, lines 2-59, Kraft).

Stenerson teaches computing a second correction term, the second correction term being equal to the sum of a product of the first syndrome with a second one of the syndromes, and a third one of the syndromes (col. 7, line 62-63, col. 18, lines 28-33, Stenerson).

- As per claim 34, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations.

Kraft teaches means for determining whether the second correction term is equal to zero (fig. 2, 3, col. 6, lines 2-59, Kraft).

- As per claim 35, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Kraft teaches that using means equates a first one of the minimum-degree polynomials to a second one of the minimum-degree polynomials in response to a determination that the second correction term is equal to zero (fig. 2, 3, col. 1, lines 60-68, col. 6, lines 2-59, Kraft).
- As per claim 36, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Kraft teaches means for determining whether the third correction term is equal to zero (fig. 2, 3, col. 6, lines 2-59, Kraft).
- As per claim 37, Oh et al., Kraft, Baggen, Wicker and Stenerson teach the additional limitations. Kraft teaches equating a first one of the minimum-degree polynomials to a second one of the minimum-degree polynomials in response to a determination that the third correction term is equal to zero (fig. 2, 3, col. 6, lines 2-59, Kraft).

10. Claims 48, 49, 50, 51, 52, 53 are rejected under 35 U.S.C. 103(a) as being unpatentable over Alvarez et al. (US 2002/0165962 A1) in view of Kraft (US 5,343,481) and Baggen (US 5,539,755).

As per claim 48, Alvarez et al. teach an 0C-192 input/output card comprising: four OC-48 processors; and an OC-192 front-end application-specific integrated circuit (ASIC) connected to said four OC-48 processors, said OC-192 front-end ASIC having means for de-interleaving an OC-192 signal to create four OC-48 signals (figure 17, page 12, paragraphs 192-193, page 30, paragraph 470, Alvarez et al.). However Alvarez et al. do not explicitly teach the specific use of means for decoding error-correction codes embedded in each of the four OC-48 signals, said decoding means including means for generating an error polynomial associated with a given one of the error-correction codes in no more than 12 clock cycles and the decoding means uses a non-iterative algorithm.

Kraft in an analogous art teaches that the current invention teaches the non-iterative use of a decision tree with closed formulas over the Galois Field for the polynomial coefficients (col. 4, lines 35-38, Kraft). Kraft also teaches that this invention teaches a combinational circuit with no clocks and no sequential operations (col. 4, lines 39-41, Kraft). Kraft teaches that the object of the present invention...Galois Field

GF (col. 4, lines 50-57, Kraft). Kraft teaches that the invention depicted in FIG. 1...more than three errors (fig. 1, 2, col. 6, lines 2-59, Kraft).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Alvarez et al.'s patent with the teachings of Kraft by including an additional step of using means for decoding error-correction codes embedded in each of the four OC-48 signals, said decoding means including means for generating an error polynomial associated with a given one of the error-correction codes in no more than 12 clock cycles and the decoding means uses a non-iterative algorithm.

This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that it would provide the opportunity to find the error-location polynomial in a short time with several very fast computations over the Galois Field.

Oh et al. also do not explicitly teach the specific use of generating the error polynomial based on a plurality of minimum-degree polynomials.

However Baggen in an analogous art teaches that the error detecting and correcting properties are determined by the factors of the generator polynomial, i.e., in our case

$g(x)=m_0(x)m_1(x)m_3(x)\ldots,$

where each factor $m_i(x)$ is itself a polynomial. The factors themselves may be minimal (col. 4, lines 60-67, Baggen).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Oh et al.'s patent with the teachings of Baggen by including an additional step of generating the error polynomial based on a plurality of minimum-degree polynomials.

This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that generating the error polynomial based on a plurality of minimum-degree polynomials would provide the opportunity to decode data and correct errors.

- As per claim 49, Alvarez et al., Kraft and Baggen teach the additional limitations.

Kraft teaches that the decoding means includes a plurality of Galois field multiply accumulators (fig. 3, col. 8, lines 12-22, Kraft).

- As per claim 50, Alvarez et al., Kraft and Baggen teach the additional limitations.

Kraft teaches that decoding means further includes a state machine (fig. 2, 4, col. 8, lines 61-64, Kraft) for controlling the Galois field multiply accumulators (fig. 3, col. 8, lines 12-22, Kraft).

- As per claim 51, Alvarez et al., Kraft and Baggen teach the additional limitations.

Kraft teaches that the decoding means uses the Galois field multiply accumulators to generate an error polynomial for a Bose-chaudhuri-Hbcquenghem (BCH) triple-error correcting code (col. 4, lines 23-27, Kraft).

- As per claim 52, Alvarez et al., Kraft and Baggen teach the additional limitations.

Kraft teaches that the decoding means includes no more than four of said Galois field multiply accumulators (fig. 3, col. 8, lines 12-22, Kraft).

- As per claim 53, Alvarez et al., Kraft and Baggen teach the additional limitations.

Kraft teaches that decoding means includes means for computing a plurality of BCH syndromes which are used by said Galois field multiply accumulators to generate the error polynomial (fig. 1, 2, 3, col. 7, line 8 to col. 8, line 60, col. 10, lines 51-65, Kraft).

11. Claim 54 is rejected under 35 U.S.C. 103(a) as being unpatentable over Alvarez et al. (US 2002/0165962 A1), Kraft (US 5,343,481) and Baggen (US 5,539,755) as applied to claim 48 above, and further in view of Wicker (Error Control Systems for Digital Communication and Storage, 1995, Prentice-Hall, Inc.).

As per claim 54, Alvarez et al., Kraft and Baggen substantially teach the claimed invention described in claim 48 (as rejected above).

However Alvarez et al., Kraft and Baggen do not explicitly teach the specific use of the decoding means that locates errors within the data signal by applying Chien's algorithm to the error polynomial to search for error location numbers.

Wicker in an analogous art teaches that once the error locator polynomial is known, the roots can be located through the use of the Chien search. The Chien search is a systematic means of evaluating the error locator polynomial at all elements in a GF field (fig. 9-1, pages 208-209, Wicker).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Alvarez et al.'s patent with the teachings of Wicker by including an additional step of using the decoding means that locates errors within the data signal by applying Chien's algorithm to the error polynomial to search for error location numbers.

This modification would have been obvious to one of ordinary skill in the art, at the time the invention was made, because one of ordinary skill in the art would have recognized that using the decoding means that locates errors within the data signal by applying Chien's algorithm to the error polynomial to search for error location numbers would provide the opportunity to determine the location of all the errors in the code word by determining all roots of the error locator polynomial.

Allowable Subject Matter

12. Claim 9 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

13. The following is a statement of reasons for the indication of allowable subject matter:

The present invention relates to data transmission systems, such as those used in computer and telecommunication networks. More specifically, the present invention is directed to an improved method and apparatus for providing error correction in a SONET transmission system.

Claim 9 recites various features:

Generating the error polynomial based on the following six equations:

(1) $d_0 = S_1$,

(2) $d_1 = S_3 + S_1S_2$,

(3) $\sigma^1(X) = 1 + S_1X$,

(4) if ($d_1 = 0$) then $\sigma^2(X) = \sigma^1(X)$

else if ($d_0 = 0$) then $\sigma^2(X) = q_0\sigma^1(X) + d_1X^3$

else $\sigma^2(X) = q_0\sigma^1(X) + d_1X^2$,

(5) $d_2 = S_5\sigma 0 + S_4\sigma 1 + S_3\sigma 2 + S_2\sigma 3$, and

(6) if ($d_2 = 0$) then $\sigma^3(X) = \sigma^2(X)$

else $\sigma^3(X) = q_1\sigma^1(X) + d_1X^3$,

where S_i are the syndromes, σ^i are the minimum-degree polynomials, σ_i are four coefficients for $\sigma^2(X)$, d_0-d_2 are correction factors, q_0-q_1 are additional correction factors, q_0 is equal to d_0 unless d_0 is zero, when q_0 is 1, and q_1 is equal to d_1 unless d_1 is zero, when $q_1 = q_0$.

The prior art of record (Oh et al. US 5,583,499) teaches a method and apparatus capable of calculating an error locator polynomial by employing a reduced number of multipliers (col. 2, lines 43-45, Oh et al.).

Kraft (US 5,343,481) teaches a fast combinational decoder circuit capable of converting the first three odd components of the syndrome vector of a three-error correcting (or less) binary BCH code into the three non-trivial coefficients of the error-location polynomial over the Galois Field (col. 4, lines 51-56, Kraft).

Baggen (US 5,539,755) teaches to provide a unitary protection format for defined control bits that offers an elevated protection level, while retaining space for later definable bits that would also have a particular error protection level (col. 2, lines 3-6, Baggen).

Wicker teaches the decoding algorithms for binary BCH codes (page 204, Wicker).

Erhart et al. (US 5,051,999) teaches that to provide a programmable error correcting means for correcting two bit errors in a code word structure having more information bits than parity bits (col. 2, lines 46-49, Erhart et al.).

Stenerson (US 4,597,083) teaches an apparatus for correcting single and double errors in a received data block utilizing a Reed-Solomon code (col. 5, lines 26-28, Stenerson).

Wolf (US 6,385,751 B1) teaches a programmable, reconfigurable implementations of Reed-Solomon encoder/decoder devices (col. 5, lines 29-31, Wolf).

Maki et al. (US 4,873,688) teach a Galois Field error correction decoder, which can correct an error in a received polynomial (col. 1, lines 51-52, Maki et al.).

Alvarez et al. (US 2002/0165962 A1) teach to provide a line card manager architecture for managing line cards at an optical switch in an optical communications network (page 1, paragraph 4, Alvarez et al.).

The prior arts however do not teach generating the error polynomial based on the following six equations:

(1) $d_0 = S_1$,

(2) $d_1 = S_3 + S_1S_2$,

(3) $\sigma^1(X) = 1 + S_1X$,

(4) if ($d_1 = 0$) then $\sigma^2(X) = \sigma^1(X)$

else if ($d_0 = 0$) then $\sigma^2(X) = q_0\sigma^1(X) + d_1X^3$

else $\sigma^2(X) = q_0\sigma^1(X) + d_1X^2$,

(5) $d_2 = S_5\sigma0 + S_4\sigma1 + S_3\sigma2 + S_2\sigma3$, and

(6) if ($d_2 = 0$) then $\sigma^3(X) = \sigma^2(X)$

else $\sigma^3(X) = q_1\sigma^1(X) + d_1X^3$,

where S_i are the syndromes, σ^i are the minimum-degree polynomials, σ_I are four coefficients for $\sigma^2(X)$, d_0-d_2 are correction factors, q_0-q_1 are additional correction factors, q_0 is equal to d_0 unless d_0 is zero, when q_0 is 1, and q_1 is equal to d_1 unless d_1 is zero, when $q_1 = q_0$.

Hence the prior art taken alone or in any combination fail to teach the claimed novel feature in claim 9 in view of its base and intervening claims.

14. Claims 38-47 are allowed.

The following is an examiner's statement of reasons for allowance:

The present invention relates to data transmission systems, such as those used in computer and telecommunication networks. More specifically, the present invention is directed to an improved method and apparatus for providing error correction in a SONET transmission system.

Claim 38 recites various features:

A decoder circuit comprising a plurality of Galois field multiply accumulators; and a state machine programmed to use the Galois field multiply accumulators to generate an error polynomial based on the following six equations:

(1) $d_0 = S_1$,

(2) $d_1 = S_3 + S_1S_2$,

(3) $\sigma^1(X) = 1 + S_1X$,

(4) if ($d_1 = 0$) then $\sigma^2(X) = \sigma^1(X)$

else if ($d_0 = 0$) then $\sigma^2(X) = q_0\sigma^1(X) + d_1X^3$

else $\sigma^2(X) = q_0\sigma^1(X) + d_1X^2$,

(5) $d_2 = S_5\sigma 0 + S_4\sigma 1 + S_3\sigma 2 + S_2\sigma 3$, and

(6) if ($d_2 = 0$) then $\sigma^3(X) = \sigma^2(X)$

else $\sigma^3(X) = q_1\sigma^1(X) + d_1X^3$,

where S_i are the syndromes, σ^i are minimum-degree polynomials, σ_i are four coefficients for $\sigma^2(X)$, d_0-d_2 are correction factors, q_0-q_1 are additional correction factors, q_0 is equal to d_0 unless d_0 is zero, when q_0 is 1, and q_1 is equal to d_1 unless d_1 is zero, when $q_1 = q_0$.

The prior art of record (Oh et al. US 5,583,499) teaches a method and apparatus capable of calculating an error locator polynomial by employing a reduced number of multipliers (col. 2, lines 43-45, Oh et al.). Kraft (US 5,343,481) teaches a fast combinational decoder circuit capable of converting the first three odd components of the syndrome vector of a three-error correcting (or less) binary BCH code into the three non-trivial coefficients of the error-location polynomial over the Galois Field (col. 4, lines 51-56, Kraft). Baggen (US 5,539,755) teaches to provide a unitary protection format for defined control bits that offers an elevated protection level, while retaining space for later definable bits that would also have a particular error protection level (col. 2, lines 3-6, Baggen).

Wicker teaches the decoding algorithms for binary BCH codes (page 204, Wicker).

Erhart et al. (US 5,051,999) teaches that to provide a programmable error correcting means for correcting two bit errors in a code word structure having more information bits than parity bits (col. 2, lines 46-49, Erhart et al.).

Stenerson (US 4,597,083) teaches an apparatus for correcting single and double errors in a received data block utilizing a Reed-Solomon code (col. 5, lines 26-28, Stenerson).

Wolf (US 6,385,751 B1) teaches a programmable, reconfigurable implementations of Reed-Solomon encoder/decoder devices (col. 5, lines 29-31, Wolf).

Maki et al. (US 4,873,688) teach a Galois Field error correction decoder, which can correct an error in a received polynomial (col. 1, lines 51-52, Maki et al.).

Alvarez et al. (US 2002/0165962 A1) teach to provide a line card manager architecture for managing line cards at an optical switch in an optical communications network (page 1, paragraph 4, Alvarez et al.).

The prior arts however do not teach a decoder circuit comprising a plurality of Galois field multiply accumulators; and a state machine programmed to use the Galois field multiply accumulators to generate an error polynomial based on the following six equations:

(1) $d_0 = S_1$,

(2) $d_1 = S_3 + S_1S_2$,

(3) $\sigma^1(X) = 1 + S_1X$,

(4) if ($d_1 = 0$) then $\sigma^2(X) = \sigma^1(X)$

else if ($d_0 = 0$) then $\sigma^2(X) = q_0\sigma^1(X) + d_1X^3$

else $\sigma^2(X) = q_0\sigma^1(X) + d_1X^2$,

(5) $d_2 = S_5\sigma 0 + S_4\sigma 1 + S_3\sigma 2 + S_2\sigma 3$, and

(6) if ($d_2 = 0$) then $\sigma^3(X) = \sigma^2(X)$

else $\sigma^3(X) = q_1\sigma^1(X) + d_1X^3$,

where S_i are the syndromes, σ^i are minimum-degree polynomials, σ_i are four coefficients for $\sigma^2(X)$, d_0-d_2 are correction factors, q_0-q_1 are additional correction factors, q_0 is equal to d_0 unless d_0 is zero, when q_0 is 1, and q_1 is equal to d_1 unless d_1 is zero, when $q_1 = q_0$.

Hence, the prior arts of record do not anticipate nor render obvious the claimed inventions. Thus, claim 38 is allowable over the prior arts of record. Claims 39-47 are allowed because of the combination of additional limitations and the limitations listed above.

- Thus, claim 38-47 are allowable over the prior arts of record.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dipakkumar Gandhi whose telephone number is 571-272-3822. The examiner can normally be reached on 8:30 AM - 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Albert Decady can be reached on (571) 272-3819. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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